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ABSTRACT

Thirty eight studies which employed Graduate Record Examinations (GRE) scores in predicting success in graduate study are reviewed. The report is presented in four sections--summary of findings by major field of study (23 different major fields); 21 studies employing varied criteria of success; 13 studies employing grade-point average as the criterion; and predicting graduate school success of foreign students (2 studies). While cautioning the reader about the dangers of drawing conclusions from these studies, the authors nonetheless make four broad generalizations: (1) students with higher test scores perform at a higher level in graduate school than those with lower scores; (2) the verbal ability score is most highly related to performance in subjects of a descriptive nature, for example the humanities, while the quantitative ability score is usually more predictive in the physical sciences; (3) advanced test scores in the appropriate subject were useful predictors and improved the correlation when used along with the aptitude test scores; and (4) best prediction was obtained when undergraduate grades and test scores were used in combination. (Author/BCF)

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GRE

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GRE

REVIEW OF STUDIES EMPLOYING GRE SCORES IN PREDICTING SUCCESS IN GRADUATE STUDY 1952-1967

Gerald V. Lannholm

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INTRODUCTION

Studies conducted prior to 1951 concerning the effectiveness of Graduate Record Examinations in predicting graduate school success were summarized by Lannholm and Schrader (16). That report is now out of print. Since that time, significant changes have been made in the examinations. The number of graduate schools using the test scores in evaluating the fitness of applicants for admission has increased greatly. Therefore, a review of studies undertaken since the 1951 summary was published seems appropriate.

This report reviews some thirty-six different studies which employed GRE scores in predicting success in graduate study. It includes the unpublished studies brought to the attention of the Graduate Record Examinations office at Educational Testing Service.

It is hazardous to attempt to formulate generally applicable conclusions from the findings of the many and varied studies covered in this report. However, a few summary statements seem warranted and may prove useful.

> In general, students with higher test scores perform at a higher level in graduate study than do those with lower test scores. Since other factors also affect actual performance, this relationship is by no means perfect and often varies from department to department and from one graduate school to another.

The Verbal Ability score tends to be most highly related to performance in subjects of a descriptive nature (e.g., the humanities). The Quantitative Ability score is usually more predictive in the physical sciences. In some instances, however, little difference was found between the predictive ability of these two scores. A combination of the two usually resulted in an improvement in predictive effectiveness.

The score on an Advanced Test in the appropriate subject field was found to be a useful predictor and, when used with the Aptitude Test scores, improved the correlation with performance in graduate study.

When the undergraduate record and test scores were used in combination, the predictive effectiveness was better than when either was used alone.

Variations

Reading the abstracts presented in this report will reveal that the studies varied in a number of respects. Although most of the investigators analyzed their data separately for different subject fields, a few of them pooled data for several disciplines. With the exception of the follow-up studies of National Science Foundation fellowship awardees, however, no study included pooled data from more than one graduate school.

The most frequently used measure of success was the graduate school grade-point average of the student. However, some investigators employed special ratings by the faculty, a few used performance on a local examination for doctoral candidates, and four used attainment of the Ph.D. degree, or the meeting of all requirements for it, as the criterion of success.

There were variations also in the data analysis methods used to determine effectiveness of the test scores in predicting success in

graduate study. The most commonly used technique was correlational analysis. However, a few investigators made direct comparisons of the average test scores for the students in two or more groups classified according to broad levels of graduate school performance.

These differences in the nature of the studies may account, in part, for many of the different findings.

Persistent Problems

A review of these studies also shows the persistence of certain problems. One is the small number of cases available. Because types of students sought, programs of study, and performance standards vary not only between universities but also from one department to another, it is best to conduct selection evaluation studies by department. However, when this is done, the number of graduate students accepted each year is often too small to make reliable statistical studies feasible. Thus, in many departments it takes several years to accomulate enough cases for a study that will yield meaningful results. Also, if some of the students to be included in the study began graduate work several years earlier than others, it may not be appropriate to pool their data, particularly if admission requirements, curricula, or performance standards have changed during the period of time under consideration.

Another problem is the lack of a satisfactory single index of the effectiveness of the predictor(s) in forecasting success in graduate study. The correlation coefficient is the most commonly used statistic. Yet, it is difficult for the person untrained in statistics to interpret, and it should be interpreted with some caution when used in prediction

studies at the graduate level. Although it is quite sound for expressing the relationship between two variables (e.g., predictor and criterion), it is sensitive to restriction in range. Therefore, it seldom produces high values for highly selected groups, or for groups for whom criterion values (e.g., grades) have little dispersion.

A further--and crucial--problem arises in the measures of graduate school success. Typically, the only evaluation of performance available is the grade-point average. Although the grades assigned do represent faculty judgments of student performance, they indicate performance only in courses taken. Too, the grades seldom have much range; except for the occasional student given an unsatisfactory grade, most of the grades are A's or B's. For these and other reasons, many investigators feel that factors other than course grades should be used in judging degree of success in graduate study.

Finally, even though the undergraduate record is viewed generally as an important index of graduate study potential, no more than one-third of the studies reviewed herein included it among the predictor variables used. This is both surprising and disappointing. Earlier studies have demonstrated its usefulness despite its low reliability and variability from one college to another. Indeed, the value of GRE test scores in the selection of graduate students is usually considered to lie in their contribution as data supplementary to the undergraduate record. The effectiveness of the test scores is properly judged by how much they improve prediction and not by how well they will do the job alone.

One further word of caution. It would not be safe to assume that the results of any of these studies would apply in all subjects in all graduate schools. However, a careful study of the findings may yield suggestions to individual departments for designing and conducting their own studies.

The remainder of this report is presented in four sections. To assist the reader primarily interested in the selection of students for graduate study in a particular discipline, the findings of the studies are assembled and summarized briefly by subject field in the section immediately following this introduction. The other three sections contain abstracts of the individual studies. In the first of these are studies employing varied criteria of success. In the second are studies employing only the grade-point average as criterion. The final section reports on two studies of the problem of predicting graduate school success of foreign students.

SUMMARY OF FINDINGS BY MAJOR FIELD OF STUDY

(Margin numbers correspond to abstract numbers in following sections, pages 19 to 38.)

Agronomy

2 A significant correlation of .30 was found between Quantitative Ability scores and faculty ratings of graduate school performance in agronomy at Purdue University.

Art

31 At Sacramento State College unusually high correlations were obtained between Aptitude Test scores and graduate grade-point averages. The correlations for Verbal Ability and Quantitative Ability were each .72. These correlations were found to be statistically significant, but it should be noted that there were only 14 students in the group.

Biology

Two of the studies reviewed included the field of biology.

4 For National Science Foundation fellowship winners, Creager used doctorate attainment as the criterion and pooled cases from different institutions. He found higher rates of attainment among those with high test scores than among those with lower test scores. In general, the three test scores showed similar positive correlations with the criterion, with a composite of the three yielding somewhat higher prediction.

24 A study at Florida State University, involving only 19 biological sciences students, produced a correlation of .317 between Verbal Ability scores and graduate grade-point averages.

Business Administration

31 For a group of 35 students in this field at Sacramento State College, a correlation of .36 was obtained between Verbal Ability scores and graduate average grades.

Chemistry

Several of the studies reviewed involved separate analyses for graduate students in chemistry. Although the predictors, the criteria of success, and the methods of data analysis varied, positive relationships were found between test scores and level of performance in graduate study in all of these studies.

Chemistry (cont.)

3 A study at Yale classified students in three levels according to a combination of grades and faculty ratings. When the students were also classified into three groups according to their scores on the Advanced Chemistry Test, a close correspondence was observed between the two classification bases.

4 Creager's study of National Science Foundation fellowship winners included both the Aptitude Test and the Advanced Chemistry Test and used doctorate attainment as the criterion. The correlations were somewhat different for males than for females but for each group the Advanced Chemistry Test was the best predictor. For males the correlation was .31; it was .37 for females.

The other studies did not use Advanced Chemistry Test
10 scores. A study at the University of Southern California yielded correlations of .42 and .55 respectively for the Verbal Ability and Quantitative Ability scores with a
2 departmental background examination. Besco at Purdue obtained a correlation with special ratings of .23 for Verbal Ability and .27 for Quantitative Ability.

Economics

25 The one study that dealt with the field of economics reported a positive correlation of .40 between the Verbal Ability score and graduate grade-point average for the students in that subject.

Education

Thirteen of the studies reviewed in this report were concerned with or included graduate students in education. Ten of the investigators used grade-point averages as the criterion of success in graduate study. Nearly all used the Aptitude Test scores as predictors but a few used scores on the Advanced Education Test.

8 At the University of Southern California, Law obtained a correlation of .72 between the Verbal Ability score and the total score on the local comprehensive examination. Verbal Ability also predicted best the examination rating in Educational Psychology and Guidance (r=.68) and that in History and Philosophy of Education (r=.60). Students passing the total comprehensive examination also had significantly higher test scores than those who failed.

9 For graduate students in Psychological Foundations of Education at Teachers College, Columbia University, Lorge found the following correlations between the Doctoral

Education (cont.)

Examination and GRE scores: Verbal Ability, .63; Quantitative Ability, .32; and Advanced Psychology Test, .41.

The following table presents the correlations obtained in the ten studies using grade-point averages as the criterion of graduate study success.

Relationship between Predictors and Graduate Average Grades for Students in Education

(Abstract number)	Institution	Predictors	Correlation with Criterion	Multiple R
32	Bradley University	Adv. Ed.	.34	
25	"Eastern Graduate Sch."	V	.26	
24	Florida State University	V	.40	
		Q	.46	
18	Florida State University	V	.36	
		Q	.30	
31	Sacramento State College			
	Admin. & Supervision	V	.45	
	Other Ed. Fields	Q	.69	
28	South Carolina State College	V & Q	.34	
		Adv. Ed.	.49	
		Ug, Adv. Ed.		.57
29	University of Detroit	V	.27	
		Q	.23	
		V & Q	.33	
23	Utah State University	V	.36	
		Q	.37	
22	West Va. University	V	.23	
		Ug, V		.32
30	Winona State College	Ug, Adv. Ed.		.30
		Ug, Adv. Ed., MAT		.52

Education (cont.) 18 Using faculty ratings on each of five qualities separately, Harvey obtained the following correlations with the Verbal Ability score at Florida State University.

Quality Rated	Correlation
Fundamental Knowledge	.63
Basic Research Techniques	.53
Written Expression	.66
Intellectual Breadth	.62
Overall Quality of Work	.62

15 At the University of Oklahoma, Rupiper used attainment of the doctorate as the criterion of success and found the Verbal Ability and Advanced Education Test scores significantly higher for the successful than for the unsuccessful graduate students in education.

Engineering 2 Correlations of .47 and .51 were found by Besco at Purdue University for civil engineering and industrial engineering respectively between Verbal Ability scores and faculty ratings of success.

4 In the study of National Science Foundation fellowship awardees, Creager used doctorate attainment as the criterion. For engineering students he found a biserial correlation of .45 between the Advanced Engineering Test score and the criterion. Correlations of .41 and .31 were found for the Verbal Ability and Quantitative Ability scores respectively.

English 27 A study at Princeton University revealed that the Verbal Ability and Advanced Literature Test scores were each useful in predicting performance in graduate study. The investigator concluded that applicants with low scores on either test had low probabilities of success. Four-fifths of those with scores of 700 or above had above average or average course performance.

Forestry 12 One study was published in 1955 based on data for 33 students in a one-year Master of Forestry program at Yale. Correlations obtained were as follows:

Forestry (cont.)

Predictors	Correlations with Average Grades	Correlations with Faculty Ratings
Verbal Ability	.33	.25
Quantitative Ability	.56	.63
Advanced Biology Test	.35	.22
Best weighted Combination of Above	.62	.64

Geology

21 Performance on the Graduate Record Examinations was found to be related to success in graduate study in geology at Yale. A composite rating by faculty members of each of 78 students constituted one criterion. The score on the Advanced Geology Test was the best single predictor.

Predictors	Correlation with Ratings
Verbal Ability	.32
Quantitative Ability	.38
Advanced Geology Test	.51
Best weighted Combination of Above	.54

It was also found that 68 percent of those with scores of 600 or above on the Advanced Geology Test had earned either the Ph.D. or a Master's degree while only 31 percent of those with scores below 600 had done so.

4 Using doctorate attainment as the criterion, Creager's study of National Science Foundation fellowship awardees revealed the highest correlation for Verbal Ability (r=.41). The correlation was .37 for Quantitative Ability and .27 for the Advanced Geology Test score.

History

31 Two studies reported data separately for the field of history, both using graduate average grades as the criterion. At Sacramento State College a significant correlation of .57 was found for the Advanced History Test.

History (cont.)	25	A correlation of .47 was found for the Verbal Ability score at an "Eastern Graduate School". Only the Aptitude Test was used as a predictor in that study.
Industrial Education	1	The Verbal Ability and Quantitative Ability scores of successful doctoral candidates were found to be significantly higher than those for unsuccessful candidates in a study of graduate students in industrial education at Wayne State University.
	32	At Bradley University, Robinson obtained a significant correlation of .34 between the Advanced Education Test score and graduate average grades in industrial arts education.
Library	24	For a group of 29 graduate students in library study at Florida State University, it was found that the correlation with graduate average grade was .48 for Verbal Ability and .45 for Quantitative Ability. The sum of these two scores yielded a correlation of .57 with the average grades.
Mathematics	31	Scores on the Advanced Mathematics Test yielded a statistically significant correlation of .76 with graduate average grades at Sacramento State College.
	4	Creager found scores on the Advanced Mathematics Test to be substantially correlated (r=.47) with a criterion of doctorate attainment for National Science Foundation fellowship recipients.
	25	A correlation of .46 was obtained by Madaus at an "Eastern Graduate School" between the Quantitative Ability score and graduate grade-point average. A combination of the Verbal Ability and Quantitative Ability scores and the undergraduate average yielded a multiple correlation of .69 with the graduate grades.
Meteorology	24	For a group of 11 students at Florida State University, the correlations with graduate grade-point average were .59 for Verbal Ability and .48 for Quantitative Ability. The sum of the two scores yielded a correlation of .599.
Music	24	At Florida State University the Verbal Ability score showed a correlation of .37 with graduate average grades. The correlation for Quantitative Ability was .25.

Nursing	25	Madaus found a significant correlation of .33 between Quantitative Ability and graduate grade-point averages in the nursing department at an "Eastern Graduate School."
Occupational Therapy	26	For graduate students in occupational therapy at the University of Southern California, significant correlations of .31 and .49 respectively were obtained between the Verbal Ability and Quantitative Ability scores and graduate grade-point averages. A correlation of .54 was obtained between the grade averages and the sum of these scores.
Pharmacy	2	Faculty ratings and the Quantitative Ability scores yielded a correlation of .38 for graduate students in pharmacy at Purdue University.
Physics	4	For National Science Foundation fellowship awardees in Physics, Creager found the scores on the Advanced Physics Test to be more highly predictive of doctorate attainment than either the Verbal Ability or Quantitative Ability scores. The correlations were .19 and .33 for these two Aptitude Test scores respectively and .41 for the Advanced Physics Test.
	19	At the University of Chicago, graduate students in physics who had obtained the Ph.D. degree or who had passed the candidacy examination had a higher mean score on the Advanced Physics Test at the time of admission than did those who were asked to discontinue because of low grades or had failed at two attempts at the candidacy examination.
	11	Michels made separate studies in the physics departments of two universities, studying the relationship between the Advanced Physics Test and the Aptitude Test scores and graduate performance in physics. The relationships were studied after one year of graduate study and again at the end of a three-year period. The Advanced Physics Test and the Quantitative Ability scores were found to be quite highly predictive in one institution but less so in the other. The author concluded that ". . .candidates with scores above 600 to 650 on the GRE Advanced Physics Test have a much greater probability of doing satisfactory work in physics than those with lower scores."

Psychology

The results of studies in the field of psychology show that the test scores are positively and usefully related to level of performance in graduate study. It also appears that in general the Advanced Psychology Test, where used, was somewhat the best predictor.

4 For National Science Foundation fellowship winners, Creager found the Advanced Psychology Test to be the best predictor of doctorate attainment.

5 Using pass or fail on the doctoral candidacy examination as a criterion, Gorman obtained a biserial correlation of .62 between it and scores on the Advanced Psychology Test at New York University.

The correlations obtained by other investigators between the test scores and various criteria are shown in the following table.

Relationship of Test Scores with Performance in Graduate Study in Psychology

(Abstract number)	Institution	Predictor(s)	Correlation with Grades	Ratings	Dept'l Exams
2	Purdue Univ.				
	Clinical	V		.32	
	Experimental	V		.47	
	Experimental	Q		.57	
24	Florida State University	V	.55		
		Q	.60		
		V & Q	.64		
32	Bradley Univ.	Adv. Psych.	.59		
16	Univ. of Miami	V			.32
		Q			.24
		Adv. Psych.			.56
5	New York Univ.	V	.23		
		Adv. Psych.	.37		
13-14	Univ. of Florida	V & Q		.29	
		Ug, V & Q		.44	
		Ug, V & Q, MAT		.32	.54

Sociology	2	Only one of the studies reviewed in this report included a study of graduate students in sociology. At Purdue, Besco found a significant correlation of .56 between the Quantitative Ability score and faculty ratings of the graduate study performance of 24 students. Advanced Test scores were not used.

STUDIES EMPLOYING VARIED CRITERIA OF SUCCESS

1 BENSON (2), in a study completed at WAYNE STATE UNIVERSITY in 1958, studied 56 doctoral candidates in INDUSTRIAL EDUCATION. Twenty-five had completed all requirements for the degree and were designated "successful". The remaining 21 were classified as "unsuccessful", having left before satisfying the degree requirements.

Employing analysis of variance, Benson found statistically significant differences (at the .01 level) between the two groups with respect to their GRE Verbal Ability scores, their Quantitative Ability scores, and scores on the Miller Analogies Test.

2 BESCO (4) conducted a study at PURDUE UNIVERSITY, separately in each of seven departments, investigating the relationship between scores on the GRE Aptitude Test and success in graduate study. The criteria were grade-point averages and special ratings by the faculty. Paired-comparison ratings were obtained from staff members on overall performance.

Correlations significant at the .05 confidence level were obtained between Verbal Ability scores and paired-comparison scores for students in the departments of chemistry (r=.23, N=82), civil engineering (r=.47, N=26), industrial engineering (r=.51, N=16), clinical psychology (r=.32, N=40), and experimental psychology (r=.47, N=20).

Significant correlations between Quantitative Ability scores and the criterion were obtained for the students in agronomy (r=.30, N=42), chemistry (r=.27, N=82), pharmacy (r=.38, N=44), experimental psychology (r=.57, N=20), and sociology (r=.56, N=24).

3 In an unpublished study reported by Lannholm (15), BERGMANN (3) compared scores on the Advanced Chemistry Test with graduate school performance of 59 students in the YALE UNIVERSITY CHEMISTRY DEPARTMENT. The criterion of performance was a rating based on actual grades in course work and evaluation by the student's research adviser. The ratings were defined as: A=above average, very good to superior, above 88; B=average, the good reliable students, 78-88; C=below average, if not poor, below 78. The Advanced Chemistry Test scores were classified into three groups: above 790, 700-790, and below 700.

Of the 11 students who rated A, 82 percent had scores above 790 and 18 percent below 700. Thirteen percent of the 30 students rated B scored above 790, 63 percent between 700 and 790, and 23 percent below 700. Of the 18 C students, 6 percent scored above 790, 22 percent between 700 and 790, and 72 percent below 700.

4 In a comprehensive follow-up study of applicants for NATIONAL SCIENCE FOUNDATION GRADUATE FELLOWSHIPS in the sciences, CREAGER (8) used attainment of the doctorate as the basic criterion of success in graduate study. Starting with approximately 4,500 fellowship applicants, he selected a stratified sample of 2,488 with scores on the Advanced Tests corresponding to those of the candidates tested in the GRE National Program for Graduate School Selection in 1960-1961.

For each of three test scores (Advanced Test, Verbal Ability, and Quantitative Ability) he plotted curves to show the relationship between rate of doctorate attainment and level of test performance. This was done separately by different fields of study and by sex within each field. In general, the curves based on the Advanced Test scores "...show a generally steady increase in the probability of doctorate attainment as the test performance level increases." Although the relationships in the case of Verbal Ability and Quantitative Ability were less marked than for the Advanced Tests, they were nevertheless positive.

Correlation coefficients were also computed between test scores and three different versions of the doctorate attainment criterion. These included biserial, point-biserial, and multiple correlation coefficients. The validities obtained were highest for the Advanced Test in all but two subgroups: males taking the Advanced Biology Test and males taking the Advanced Geology Test. These differences were not statistically significant. Combining the three scores resulted in small increases in the multiple correlations which were consistently higher than the validities obtained for the Advanced Test alone.

In the same report, Creager also describes a study based on a group of 3,491 applicants for 1955 and 1956 fellowships. For these subjects the data used to predict doctorate attainment were the GRE scores, undergraduate grade point average in science and

mathematics, and reference-report average ratings. The effectiveness of various combinations of these predictors was also evaluated.

The validity coefficients obtained for the Advanced Test were highest in most instances. Next highest were those for Quantitative Ability. Those for grade-point averages and reference-report ratings followed and were of about equal magnitude. With respect to the various combinations of predictors, the author concludes:

> "...it appears that the Advanced Test usually does just about as well as does the three-test composite, although in the more verbal fields such as biology and psychology, the Verbal Test does add a little to the prediction. Beyond this, the addition of grade-point average and reference-report ratings makes little difference, and when one is added, no further gain is made by adding the other."

In his summary of the two studies the author concluded, in part:

> "Both studies confirm that the Graduate Record Examinations have significant validity for prediction of doctorate-attainment criteria, even within the upper levels of test performance. Both studies confirm the greater validity of the Advanced Test over the Aptitude Test."

5 As early as 1953, GORMAN (10) completed a study involving PSYCHOLOGY students at NEW YORK UNIVERSITY who had taken at least four graduate courses. Predictors included GRE Aptitude Test and Advanced Psychology Test scores as well as scores on the Miller Analogies Test. As criteria of graduate school success, he used graduate grade-point average and pass-or-fail performance on the preliminary qualifying examination for doctoral candidacy.

Only the Verbal Ability ($r=.22$) and Advanced Psychology Test ($r=.37$) scores yielded statistically significant correlations with grade-point averages, the former being significant at the .05 level and the latter at the .01 level. Biserial correlations between the pass-and-fail groups were .62 for the Advanced Psychology Test and .43 for the Miller Analogies Test, both significant at the .01 level.

6 Summarizing fourteen years of research on fellowship selections for the National Science Foundation, HARMON (11) included a report of results obtained in studies designed to predict on-the-job effectiveness following doctorate attainment. Positive but relatively low correlations were obtained between Advanced Test scores and each of three criteria: publication counts, citation counts, and on-the-job ratings.

7 In their study of 119 doctoral candidates who had received PURDUE Research Foundation fellowships between September 1956 and September 1958, KING and BESCO (14) asked faculty members to rate each student on his overall performance in graduate work, and to indicate whether or not "they would have recommended the ratee for a fellowship had they known how he would perform as an X-R Fellow." Students were than ranked within their own departments on the basis of the faculty ratings, their grade-point averages, and their GRE Aptitude Test scores.

Critical ratios significant at the .05 level were found between rank on Verbal Ability and rank on faculty rating, as well as between Verbal Ability and a combination of grade-point average and faculty rating. None of the critical ratios using Quantitative Ability were statistically significant.

A phi-coefficient of .34, significant at the .01 level, was obtained between the Verbal Ability scores and faculty ratings. On the basis of variance tests for both the Verbal Ability and Quantitative Ability scores, it was recommended that cut-off scores for admissions purposes be established on a departmental, rather than a university-wide, basis.

8 LAW (17) conducted a study that involved 46 doctoral candidates in the SCHOOL OF EDUCATION at the UNIVERSITY OF SOUTHERN CALIFORNIA. As predictors he used scores on the GRE Aptitude Test and on the GRE Area Tests. The criteria were ratings on the school's five comprehensive examinations, four of which were in History and Philosophy of Education, Educational Psychology and Guidance, Administration, and Curriculum. The fifth consisted of the total comprehensive examination, which partially determined admission to the program for the doctorate.

Of the total group of 46 students, 24 failed and 22 passed. The successful students scored significantly higher (at the .01 level) on all predictors and on all criteria. For the total group, the best predictors of the total comprehensive examination rating were the Verbal Ability and Social Sciences (in the Area Tests) scores, each correlating .72 with the criterion.

The Verbal Ability score was the best predictor of the examination rating in Educational Psychology and Guidance (r=.68) and in History and Philosophy of Education (r=.60). The score on the Social Science Test predicted the examination rating most effectively for Administration (r=.56) and Curriculum (r=.63).

9 Using the score on the doctoral written examination as the criterion for 165 graduate students majoring in Psychological Foundations of EDUCATION at TEACHERS COLLEGE, COLUMBIA UNIVERSITY, LORGE (18) obtained correlations of .63 with GRE Verbal Ability score, .32 with Quantitative Ability, and .41 with the Advanced Psychology Test score.

10 MICHAEL et al (21) used a departmental background examination as the criterion in a study involving 41 graduate students in CHEMISTRY at the UNIVERSITY OF SOUTHERN CALIFORNIA. The examination consisted of three subtests: Inorganic Chemistry, Organic Chemistry, and Physical Chemistry. The predictors were scores on the GRE Aptitude Test and on the Area Tests.

Observing that the mean scores on the Quantitative Ability and the Natural Science Test were very high (643 and 642) and the standard deviations quite small (72 and 76), the investigators used 100 as an estimate of the standard deviation of an uncurtailed group of examinees, and reported that "statistically significant correlations of .55 for Quantitative, .42 for Verbal, .32 for Humanities, and .31 for Natural Sciences were obtained with B.E.-Physical and a coefficient of .33 between GRE-Natural Science and B.E.-Inorganic."

11 A special study of the predictive effectiveness of the Advanced Physics Test and the Aptitude Test in the PHYSICS departments of two graduate schools was reported by MICHELS (22) in 1966. An overall ranking (separate in each department) on performance after one year of graduate study was used as the criterion in the first part of the study.

Plotting the Advanced Test score for each student against his ranking index showed "a fairly high correlation" for one institution and little or no correlation for the other. Similar analyses involving Aptitude Test scores showed little correlation between Verbal Ability and the ranking index in either institution.

The use of Quantitative Ability as a predictor gave results similar to those obtained with the Advanced Physics Test score. Using the sum of the Advanced Physics Test and Quantitative Ability scores, a very high correlation was found for one institution and little or none at the second.

The investigator also studied relationships between the test scores and graduate school success of these students at the end of three years of graduate study. At one institution new ranking indices were compiled in the same manner as before. At the other, classifications of status after three years were furnished.

In the institution that was more selective in its admissions, the correlations were again essentially non-existent. In the other, the correlation between Advanced Physics Test scores and status classifications after three years was higher than the correlation between those scores and the ranking indices after one year of graduate study.

The author concludes that both the Advanced Physics Test scores and the Quantitative Ability scores appear to be good tools in the selection of successful graduate students.

12 OLSEN (25) conducted a study of 43 students in the YALE SCHOOL OF FORESTRY between 1951 and 1954 who had taken both the GRE Aptitude Test and the Advanced Biology Test in October, 1949, or later. The criteria used were graduate grade-point averages and the averages of ratings of professional competence made by six faculty members on a zero-to-four scale.

Thirty-three of the students were in a one-year Master of Forestry program, having majored in forestry as undergraduates. The remaining ten were in a two-year program. The graduate grade-point average of the students in the two-year program was based on their second year of study.

The Quantitative Ability scores of all 43 students correlated .52 with faculty ratings and .51 with graduate grade-point average. The Verbal Ability scores showed correlations of .39 and .37 with faculty ratings and grade-point averages respectively. The correlation between Advanced Biology Test scores and faculty ratings was .30 and was .27 with grade-point averages.

When the 10 two-year program students were omitted from the sample, higher correlations were obtained between Quantitative Ability and faculty rating (r=.63), Quantitative Ability and grade-point average (r=.56), and Advanced Biology Test score and grade-point average (r=.35). Smaller correlations were obtained between the other pairs of variables.

Multiple correlations of the best-weighted combination of the three predictors yielded coefficients of .56 with faculty ratings and .55 with grade-point averages for the total sample. For the one-year program group, the coefficients were .64 with the ratings and .62 with average grades.

13 In 1961, ROBERTSON AND NIELSEN (28) reported the results of a study in which special faculty ratings were obtained as criterion measures. The subjects were 50 students who had entered graduate study in PSYCHOLOGY at the UNIVERSITY OF FLORIDA between 1955 and 1959 and for whom GRE Aptitude Test scores were available.

Each student was rated by nine faculty members on his intellectual capacity to obtain the Ph.D. degree. None of the raters knew the student's GRE scores nor the purpose of the study. A five-point scale was used: 1 - highest ten percent; 2 - highest third excluding top ten percent; and 5 - lowest ten percent. Each faculty member also indicated his familiarity with the student on a five-point scale that ranged from "general impression" to familiarity with the student through courses and with his performance on comprehensive examinations.

The correlation between mean GRE score and ratings was .29; between undergraduate average grade in mathematics and science and the ratings the correlation was .37 (both significant at the .05 level). A multiple correlation of these two predictors with the ratings gave a coefficient of .44, also significant at the .05 level.

When the mean GRE scores were broken down into five levels and the mean ratings into seven, it was found that no student with a mean GRE score of 655 or above had a mean rating below 3.3 (the upper limit of the middle rating level); no student with a GRE mean score above 600 fell in the lowest rating level; and no student with a GRE mean score below 590 achieved the highest rating level.

14 In a study reported in 1964, ROBERTSON AND HALL (27) added data on 23 more recent graduate students in PSYCHOLOGY at the UNIVERSITY OF FLORIDA to the Roberston and Nielsen (28)

study and then analyzed the data for the augmented sample. The criteria again included a faculty rating on capacity to receive the Ph.D. Added criteria were scores on a comprehensive examination given at the end of the second year, and peer ratings by 10 graduate students of the 23 at the end of the first year.

For the augmented sample of 73 students, a statistically significant correlation (at the .05 level) of .25 was obtained between mean GRE (V plus Q) scores and the faculty ratings. The correlation of .15 between the undergraduate average and faculty ratings was not statistically significant. None of the predictors correlated significantly with scores on the comprehensive examination or with the peer ratings, many of which yielded observed negative correlations.

A selective index based on a weighted combination of the mean GRE score, the Miller Analogies Test score, and the undergraduate grade-point average for the junior and senior years yielded a correlation of .32 (N=42) with faculty ratings and .54 (N=19) with comprehensive examination scores. Both correlations were significant at the .05 level.

The authors concluded that "...success in prediction could be improved to some extent by using a composite score that represents a combination of differentially weighted predictors."

15 Receipt of the Ph.D. was used as the criterion of success in graduate study in an investigation conducted by RUPIPER (30) at the UNIVERSITY OF OKLAHOMA in 1959. The subjects were 25 candidates for the doctoral degree in EDUCATION. Each took the GRE Aptitude Test after a year of graduate study and the Advanced Education Test following a semester or more of graduate education courses beyond the Master's degree level. Twelve of the subjects received the Ph.D. degree and 13 failed to do so. The mean Verbal Ability score and the mean score on the Advanced Education Test were significantly higher (at the .05 level) for the successful candidates than for the unsuccessful.

16 At the UNIVERSITY OF MIAMI, SISTRUNK (31) reported correlations of .32 and .24 between Verbal Ability and Quantitative Ability scores respectively, and performance on the departmental comprehensive examination for 57 graduate students in PSYCHOLOGY. For 73 students, he obtained a correlation of .56 between the departmental examination and scores on the Advanced Psychology Test.

17 Special ratings were also obtained by TULLY (34) in a study carried out at FLORIDA STATE UNIVERSITY using data on a basic sample of 1,479 students admitted to graduate study between July 1, 1955, and September 30, 1958. Separate studies by department were not made.

Ratings of success in graduate study (on 958 students) were made by their major advisers on an 11-point scale of five qualities: "degree of mastery of fundamental knowledge in the general field; knowledge of, and ability to use, the basic research techniques in the field; ability to express oneself in writing; intellectual breadth; and overall quality of graduate work." Grade-point averages in graduate study constituted another criterion. The predictor variables included the undergraduate grade-point average and scores on the GRE Aptitude Test, Advanced Tests, and Area Tests, and on the Miller Analogies Test. Not all predictor data or criterion data were available for all of the students.

Despite the pooling of data for the various departments, all of the correlations obtained between the predictors and the criteria were significant at the .05 level or better, except for that between the scores on the Natural Science Test of the Area Tests and the graduate grade-point average. These correlations were based on samples of 333 to 1,073 cases and ranged from .08 to .41.

To assess the effect of using various cut-off levels on the predictors for admissions purposes, mean criterion values (separately for faculty ratings and graduate grade-point average) for different projected admitted and rejected groups were compared. Differences statistically significant at the .01 level were obtained in all comparisons made. It was noted that raising the cut-off on any of the three variables had greater impact on decreasing the percentage of those accepted than in increasing subsequent mean ratings or graduate grade-point averages.

In testing the utility of a multiple-regression vs. a multiple-screening method of selection, the author found that "the multiple-regression procedure for organizing predictive data, although failing to select students who performed better academically than those selected by the multiple screen, led to a significantly higher proportion of correct decisions than the multiple screen." The author also concluded: "A study designed to determine the relationship of subtest scores to grades in specific departments is needed as a possible approach for establishing differential departmental-admissions strategies."

18 Using Tully's data, HARVEY (12) made a special analysis based on 89 graduate students in the Department of EDUCATION. His results showed a correlation of .30 between undergraduate and graduate grade-point averages. The correlation with graduate average grade was .36 for Verbal Ability and .30 for Quantitative Ability. Further analysis using the faculty ratings as criteria yielded correlations from .28 to .37 with the undergraduate average. Substantially more favorable predictive effectiveness was obtained for the Verbal Ability score.

Using the faculty ratings made on each student for each of five qualities separately, he obtained a correlation of .63 with Fundamental Knowledge, .53 with Basic Research Techniques, .66 with Written Expression, .62 with Intellectual Breadth, and .62 with Overall Quality of Work.

19 Another study in which successful and unsuccessful classifications were used was conducted by VOORHEES (35) and reported by Lannholm (15). Data were obtained on 68 graduate students admitted to the Department of PHYSICS at the UNIVERSITY OF CHICAGO from the fall of 1950 through the fall of 1956. The successful students were those who had obtained the Ph.D. or had passed the Ph.D. candidacy examination by autumn, 1958. Those students who had been asked to discontinue because of low grades or had failed at two attempts on the candidacy examination were classified as unsuccessful. Approximately 92 percent of those with scores of 600 or above on the Advanced Physics Test were in the successful group. Only 53 percent of those with scores below 600 were successful.

20 At HOWARD UNIVERSITY in 1952, WALLACE (36) completed a study of two groups of graduate students, the first including 100 who entered in the fall of 1949 and the second, 52 who had entered in the fall of 1948 and were still enrolled. GRE Verbal Ability and Advanced Test scores and undergraduate grade-point averages served as the predictors. The criteria employed were graduate grade-point averages and special teacher evaluations of each student on a 25-point scale.

The predictors showed higher correlations in most cases with the teacher evaluations than with the graduate grade-point average. For Group I, the correlations were: Verbal Ability, r=.35; Advanced Test score, r=.58; undergraduate average, r=.57. Used together, the two GRE scores yielded a correlation of .59. A combination of the Advanced Test score and the undergraduate average gave a correlation of .70.

21 In a study of students at YALE UNIVERSITY (23) registering in the years 1952-1961 inclusive for graduate work in GEOLOGY, the principal criterion was a composite rating of the students by faculty members. Scores on the GRE Aptitude Test and the Advanced Geology Test constituted the predictor variables.

Using optimum weights for the test scores as a "GRE Index", a correlation of .54 with the composite ratings was obtained for 78 students. The Advanced Geology Test score correlated .51 with the composite ratings; the GRE Verbal and Quantitative scores correlated .32 and .38 respectively with the ratings.

Of those with scores of 600 or above on the Advanced Geology Test, 68 percent had earned either the Ph.D. or a Master's degree; only 31 percent of those with scores below 600 had taken one of these degrees.

STUDIES EMPLOYING GRADE-POINT AVERAGE AS THE CRITERION

22 The results of a study using graduate grade-point average as the criterion of success were reported by ALEXAKOS (1). The study involved students in the COLLEGE OF HUMAN RESOURCES and EDUCATION at WEST VIRGINIA UNIVERSITY. Separate analyses were made of data collected for 92 students, 46 each in the Division of Clinical Studies and the Division of Education.

For the Clinical Studies group, correlations with the criterion were .34 for the Aptitude Test Verbal Ability score and .31 for the undergraduate average. Correlations of .23 and .26 were found for these variables for the Division of Education students. Multiple correlations of .42 and .32 were obtained for these two groups respectively.

23 BORG (5) completed a study in 1963 using data for 175 graduate students in EDUCATION at UTAH STATE UNIVERSITY. Most of these students were master's degree candidates in elementary education, secondary education, or educational administration. All had completed at least 15 hours of graduate work and had taken the GRE Aptitude Test within the preceding five years.

Using graduate grade-point average as the criterion, Borg obtained correlations of .36 and .37 with the Verbal Ability and Quantitative Ability scores respectively. He noted that "since grades in many graduate courses are limited almost entirely to A or B, the discrimination value of the GPA is reduced."

24 A study involving 314 students in thirteen different fields of study was carried out in 1958 by the Office of Institutional Research and Service, FLORIDA STATE UNIVERSITY (24). Students were included who had eight or more semester hours of graduate study, who had entered in the summer of 1953 or during 1953-1954, and who had scores on the GRE Aptitude Test. The criterion employed was a graduate grade-point average that varied from 2.4 to 4.0 with a mean of 3.4. The number of cases per field of study varied from seven in home economics to 96 in education, with the remainder falling between 11 in meterology and 26 in music.

Because of the small numbers of cases, the correlations between test scores and graduate grade-point averages were subject to large sampling errors. The total GRE score (V plus Q) showed correlations ranging from nearly .65 for psychology (N=23) to

-.12 for social welfare (N=20). Further analysis showed that among the students with GRE scores in the highest decile, 79.7 percent of the grades were "A"; among those in the lowest decile, only 32 percent of the grades were "A".

25 A study by MADAUS AND WALSH (20) investigated the differences in predictive validity of the GRE Aptitude Test among various departments in the same graduate school. Graduate grade-point average was used as the criterion.

Statistically significant correlations were obtained between Verbal Ability and the criterion for the departments of chemistry (r=.44), economics (r=.40), history (r=.47), and education (r=.26). For Quantitative Ability, statistically significant correlations were obtained for the nursing department (r=.33) and the mathematics department and mathematics institute combined (r=.46). A multiple correlation of .69 between GRE scores and grade-point averages was obtained for the mathematics institute.

26 SLEEPER (32) studied the relationship between GRE Aptitude Test scores and graduate grade-point averages for 24 women who received Master's degrees in OCCUPATIONAL THERAPY at the UNIVERSITY OF SOUTHERN CALIFORNIA. He obtained a correlation of .31 (significant at the .05 level) for the Verbal Ability score and of .49 (significant at the .02 level) for Quantitative Ability. A correlation of .54 (significant at the .01 level) was obtained between total score (V plus Q) and grade-point average.

27 An analysis of the graduate school performance of 44 students in ENGLISH was made by THORPE (23) and reported by Lannholm (15). All of the students were admitted during the period 1950-1955, and had completed the course work for the doctorate. The GRE Aptitude Test and the Advanced Literature Test had been taken by all prior to admission. Performance in graduate course work was the criterion.

The Quantitative Ability scores showed little relationship with graduate school success. However, 80 percent of the students with Verbal Ability scores of 700 or higher had average or above-average performance in graduate courses. Of those with scores below 700, approximately 61 percent had below-average course grades. For the Advanced Literature Test, 82 percent of those with scores of 700 or higher were average or above in their course performance.

Among the author's conclusions was the statement:

> "The predictive ability of the GRE scores alone is about as good as a combination of all of the other information regularly supplied, including academic records and letters of recommendation, even after adjustment in the light of knowledge of the institutions and the recommenders."

28 Using undergraduate grade-point averages and GRE scores as predictors and graduate average grades as the criterion, CAPPS AND DECOSTA (6) studied 41 graduate students who had enrolled at SOUTH CAROLINA STATE COLLEGE between 1948 and 1954 and who had completed the four basic professional courses required of all graduate students.

A correlation of .42 was obtained between undergraduate grade-point average and graduate average grade. For the total score (V plus Q) on the Aptitude Test, the correlation was .34. A correlation of .49 was obtained for the Advanced Education Test. A multiple correlation coefficient of .57 was obtained between the criterion and a combination of the undergraduate average and the Advanced Education Test score.

29 At the UNIVERSITY OF DETROIT, CONWAY (7) used data of 36 students receiving Master's degrees in EDUCATION. Undergraduate average, GRE Aptitude Test scores, and the score on the Advanced Education Test were used as predictors. The criterion was the grade-point average in graduate education courses.

The best single predictor was the undergraduate grade-point average in all courses (r=.57), followed by the undergraduate average in education courses (r=.49). Verbal Ability correlated .27 with the criterion, Quantitative Ability,.23, total Aptitude Test score (V plus Q), .33, and the Advanced Education Test, .14.

30 ECKHOFF (9) used 185 secondary EDUCATION and 111 elementary education majors with 30 or more quarter hours of graduate work at WINONA STATE COLLEGE as her sample. Predictor variables included the undergraduate average, GRE Advanced Education Test, and the Miller Analogies Test. The criterion was the overall graduate average.

Using stepwise multiple-regression analysis, a multiple correlation of .52 was obtained using all predictors for

the secondary education group. For the elementary education majors, a multiple correlation of .30 was obtained between the criterion and a combination of the undergraduate average and the Advanced Education Test score. When the Miller Analogies score was included, the value of the multiple correlation remained unchanged.

31 At SACRAMENTO STATE COLLEGE, JOHNSON AND THOMPSON (13) completed a study in 1962 in which the predictors used were the GRE Aptitude Test, the Advanced Tests, upper-division undergraduate grade-point average, and the number of years elapsed since earning the Bachelor's degree. The criterion was the grade-point average for all graduate study. Although the number of students in most subject fields was small, analysis was done by major field as well as for all combined.

The authors report a restricted range of graduate grade-point averages and of GRE scores. Correlations significant at the .05 level were obtained between the criterion and Verbal Ability for the fields of art (r=.72), educational administration and supervision (r=.45), and business administration (r=.36). For Quantitative Ability the significant correlations were in the field of art (r=.72) and "other education" (r=.69). The Advanced Test showed significant correlations for history (r=.56) and mathematics (r=.76).

The undergraduate average yielded significant correlations for art (r=.63), business administration (r=.46), educational administration and supervision (r=.38), other education (r=.50), and physical education (r=.59). With respect to years since receiving the bachelor's degree, significant correlations were obtained for history (r=.43), physical education (r=.50), and social science (r=.71). All involved small numbers of cases.

32 In a study completed in 1957, ROBINSON (29) reported results based on 285 graduate students who had entered BRADLEY UNIVERSITY between 1947 and 1949 and who had completed at least one year of graduate study. Analyses were made by field of study and for the total. Predictors used were undergraduate grade-point average and scores on the GRE Aptitude Test and Advanced Tests. The graduate grade-point average was used as the criterion.

Correlations significant at the .01 level were obtained between the criterion and undergraduate grade-point average for education (r=.39), social studies (r=.53), psychology (r=.63), natural sciences (r=.68), and total group (r=.38).

Also significant at the .01 level were the correlations for the Advanced Test score for industrial-arts education (r=.34), psychology (r=.59), natural sciences (r=.68), and total group (r=.23). Multiple correlations were not obtained.

33 ELIZABETH WHITE (37) used 35 students receiving the M.S. degree in CHEMISTRY at the UNIVERSITY OF DETROIT for a study in which the graduate average grade was employed as the criterion. The predictor variables included the overall undergraduate grade-point average, the undergraduate average in chemistry courses, and scores on the GRE Aptitude Test and the Advanced Chemistry Test.

The correlations between the predictors and the criterion ranged from .40 to .44, except that the correlation obtained between Verbal Ability and the criterion was .28. A multiple correlation of .63 was obtained between the criterion and the "best" combination of the Advanced Chemistry Test score, Quantitative Ability score, and the undergraduate average in chemistry.

34 GORDON WHITE (38) completed a study at the UNIVERSITY OF IOWA in 1967. Pooling data across departments for four groups and using graduate grade-point average as the criterion and the GRE V and Q scores as predictors, he obtained a multiple correlation of .33 for those beginning an M.A. program, .40 for those receiving an M.A., .31 for those beginning a Ph.D. program, and .12 for those receiving a Ph.D. All but the last were statistically significant at the .05 level.

Multiple correlations (significant at the .05 level) of .28 and .36 respectively were obtained for beginning doctoral students and those receiving the Ph.D. in education. A cross-validation study yielded correlations ranging from .35 to .45 between predicted and earned grades for groups of students receiving degrees in August, 1966.

PREDICTING [illegible] OF FOREIGN STUDENTS

Predicting the graduate study performance of foreign students in U. S. institutions is especially difficult. While it would be unreasonable to expect that this can be done satisfactorily by means of test scores only, it seems desirable to make some assessment of their possible contribution to the selection of foreign students. Only two studies were found which dealt with this problem.

35 MABERLY (19) collected and analyzed data for 250 male students, randomly selected from all English-speaking foreign graduate students who had enrolled at the UNIVERSITY OF SOUTHERN CALIFORNIA between 1955 and 1961 and who had GRE scores and criterion measures. The graduate average grade over a minimum of two semesters, totalling at least 12 units, was employed as the criterion.

These students were divided into two groups and studied separately. The first included 104 students from countries where English is the primary language and the culture follows a pattern similar to those with Western civilization. Included in the second group were 148 students from countries where English is not the first language and the culture differs from those in the other group. Neither of these groups was subdivided by field of study.

Bivariate correlations obtained between the criterion and Verbal Ability were .13 for Group I and .23 (significant at .01 level) for Group II. For Quantitative Ability, the correlation was .10 for each group. Multiple correlations using a combination of Verbal Ability and Quantitative Ability were .13 and .23 for Groups I and II respectively.

Using discriminant function analysis, the test scores, weighted to maximize their ability to separate the top 27 percent and the bottom 27 percent, yielded a biserial correlation of .16 for Group I for a composite of Verbal Ability and Quantitative Ability. A biserial correlation of .39 (significant at the .01 level) was obtained for Group II.

36 A study including foreign graduate students at four different universities was conducted by PITCHER AND HARVEY (26). All of the students were from countries where English is not the principal language. The criteria used were graduate average grades and special ratings by faculty members. Information concerning the graduate school status (e.g., earned Ph.D., still enrolled, withdrew, etc.) was also obtained for these students.

The correlations obtained between graduate average grades and tests scores, and between those grades and the special faculty ratings, varied from one of the graduate schools to another.

In a school in which 221 cases were used, the correlations between faculty ratings were .33 and .38 for Verbal Ability and Quantitative Ability respectively (both significant at the .01 level). The multiple correlation of a combination of the test scores with the ratings was .43. Corresponding correlations using the graduate grade averages as the criterion were .25, .44, and .45.

In a second school having 195 foreign students included in the study, the correlations with faculty ratings were .17 for Verbal Ability and .14 for Quantitative Ability. The multiple correlation was .19. Using graduate average grades as the criterion, correlations of .14 and .11 were obtained with Verbal Ability and Quantitative Ability respectively, the multiple correlation being .16.

Comparisons of levels of test performance and educational-status classifications revealed a strong positive relationship in two of the three institutions with sufficient numbers of cases for such analysis.

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